U.S. Fish and Wildlife Service

# Estimation of sockeye and coho salmon escapement in Mortensens Creek, Izembek National Wildlife Refuge, 2004

*Alaska Fisheries Data Series Number 2005-5*

King Salmon Fish and Wildlife Field Office
King Salmon, Alaska
January 2005

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This is an Annual Report for Fisheries Resource Monitoring Program Project 04-402, funded through the U.S. Fish and Wildlife Service, Office of Subsistence Management

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# Estimation of sockeye and coho salmon escapement in Mortensens Creek, Izembek National Wildlife Refuge, 2004

**Cheryl A. Dion**

## Abstract

A fixed picket weir was operated on Mortensens Creek from 1 July to 5 October 2004. Sockeye salmon *Oncorhynchus nerka* was the most abundant species counted through the weir (*n*=7,215) followed by coho *O. kisutch* (*n*=3,836), pink *O. gorbuscha* (*n*=22), and chum salmon *O. keta* (*n*=13). Dolly Varden *Salvelinus malma* (*n*=289), whitefish *Coregonus spp.* (*n*=21), and starry flounder *Platichthys stellatus* (*n*=68) were also observed at the weir. Sockeye salmon sampled at the weir were 39% female (SE=2.5%), and represented eleven age groups. Age 1.3 was estimated to be 35% (SE=2.5%) of the run, age 2.2 was 25% (2.2) and age 1.2 was 23% (SE=2.3%). The length for male sockeye salmon ranged from 401 to 634 mm and from 439 to 602 mm for females. Coho salmon sampled at the weir were 51% female (SE=2.4%) and represented five age groups. Age 2.1 comprised 63% (SE=2.3%) of the run and age 1.1 was 34% (SE=2.3%). The length for male coho salmon ranged from 400 to 701 mm and from 431 to 699 mm for females.

## Introduction

The outlet of Mortensens Creek is one of the few areas where sockeye *Oncorhynchus nerka* and coho *O. kisutch* salmon are available for harvest by subsistence users from King Cove and Cold Bay. An escapement goal of 3,200 to 6,400 (Nelson and Lloyd 2001) has been established for sockeye salmon, but currently there is no goal for coho salmon. In 1999, escapement of sockeye salmon in Mortensens Creek, based on aerial survey counts, was estimated to be 3,600 fish with an additional 1,378 sockeye salmon harvested in the subsistence and commercial fisheries (ADFG 2000). About 30% of the subsistence harvest of sockeye salmon was taken by Alaska residents living outside of Cold Bay and King Cove. Also in 1999, 279 coho salmon were harvested in the commercial and subsistence fisheries (ADFG 2000). Management of both species was based on aerial surveys of escapements, but effectiveness of these surveys was limited by dark stream bottoms, turbid water, and inclement weather. The Alaska Department of Fish and Game (ADFG) was also concerned that the lack of an in-season estimate of sockeye and coho salmon escapement into Mortensens Creek could jeopardize the continued health of these runs, as well as opportunities for subsistence and sport fishing (Arnold Shaul, ADFG, personal communication). Additionally, King Cove residents were concerned about sport fishing effects on coho salmon. The State's annual sport fish survey did not specifically estimate sport harvest for Mortensens Creek, therefore, no creel survey or harvest information was available. However, the report did provide an estimate of coho salmon sport harvest for the Cold Bay area, which primarily consists of Russell and Mortensens creeks. Average sport harvest for this area from 1996 to 1998 was 671 coho salmon (Howe et al. 1997, Howe et. al. 1998, and Howe et al. 1999).

In 2001, the U.S. Fish and Wildlife Service began operating a weir on Mortensens Creek to estimate escapement of sockeye and coho salmon (Whitton 2002 and 2003; Cornum et al. 2004). These estimates have provided managers with the data to address concerns about over harvest

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and help resolve the conflict between subsistence and sport users. Specific objectives of this study are:

1. Enumerate daily passage of sockeye and coho salmon through a weir on Mortensens Creek;
2. Describe the run-timing of sockeye and coho salmon through the weir;
3. Estimate the sex and age compositions of sockeye and coho salmon such that simultaneous 90% confidence intervals have a maximum width of 0.20;
4. Estimate the mean length of sockeye and coho salmon by sex and age;
5. From objective one, determine if the abundance of sockeye and coho salmon returns in Mortensens Creek are adequate to allow subsistence fishing, and;
6. From objective one, determine if the abundance of sockeye and coho salmon returns in Mortensens Creek are adequate to allow sport fishing.

## Study Area

Mortensens Creek originates in the foothills of Frosty Peak and flows north towards the town of Cold Bay, Alaska before eventually turning south and emptying into Mortensens Lagoon (Figure 1). Little hydrological information is available, but the drainage consists of several small tributaries, ponds, and a lake. Mortensens Creek supports populations of sockeye, coho, chum (*O. keta*), and pink (*O. gorbuscha*) salmon and Dolly Varden (*Salvelinus malma*).

## Methods

### *Weir Operations*

The King Salmon Fish and Wildlife Field Office installed and operated a weir on Mortensens Creek from 1 July to 5 October 2004. The weir was constructed of 2 m aluminum pickets with 2 cm spacing between each picket. Each panel had a minimum of three cross pieces that were welded to the pickets. Weir panels were supported by fence posts and an 8 mm diameter galvanized aircraft cable stretched across the stream. The supporting cable was anchored to the stream banks using “dead men” buried vertically at a depth that allowed the cable to be suspended just above the water surface. Each “dead man” was buried far enough from the stream channel to reduce the chance it would fail during high water. Weir panels were hooked together and placed across the channel at an angle to direct upstream migrant fish to the trap box. The continuous panel was tilted downstream in relation to the stream bed to shunt debris to the water surface, thereby maintaining free-flow of water through the pickets. The tops of the panels were wired to the supporting cable. A permeable textile cloth was placed under the weir to prevent undercutting. A fyke was installed in the weir, leading to an upstream migrant holding pen (trap box). The fyke was located as close to the stream bank as adequate depth would allow. The depth in the holding pen was greater than 0.5 m to help minimize fish escaping from the pens. The entire weir was inspected, cleaned, and maintained daily to insure integrity.

The weir was modified from previous years to include a fish passage chute and underwater video camera. This modification facilitated fish passage and reduced the number of fish handled at the weir. The passage chute was lit from the top and bottom with 4-foot fluorescent lights and from the sides with pond lights, to provide illumination necessary to record images. A baffle was installed inside the chute to lead the fish closer to the glass and enhance fish identification in turbid water. An Applied Microvideo (model 10) underwater video camera was mounted inside a sealed aluminum video box with a glass viewing panel. The video box was filled with clean water treated with algaecide and installed adjacent to the passage chute. Video images from the underwater camera were recorded using a GYYR DVMS 400 video time lapse recorder. Motion detection hardware and software were used to eliminate blank footage for later counting and identification. Fish were not allowed to hold downstream of the weir. If this occurred, the trap box was closed and the video chute was operated to facilitate upstream passage.

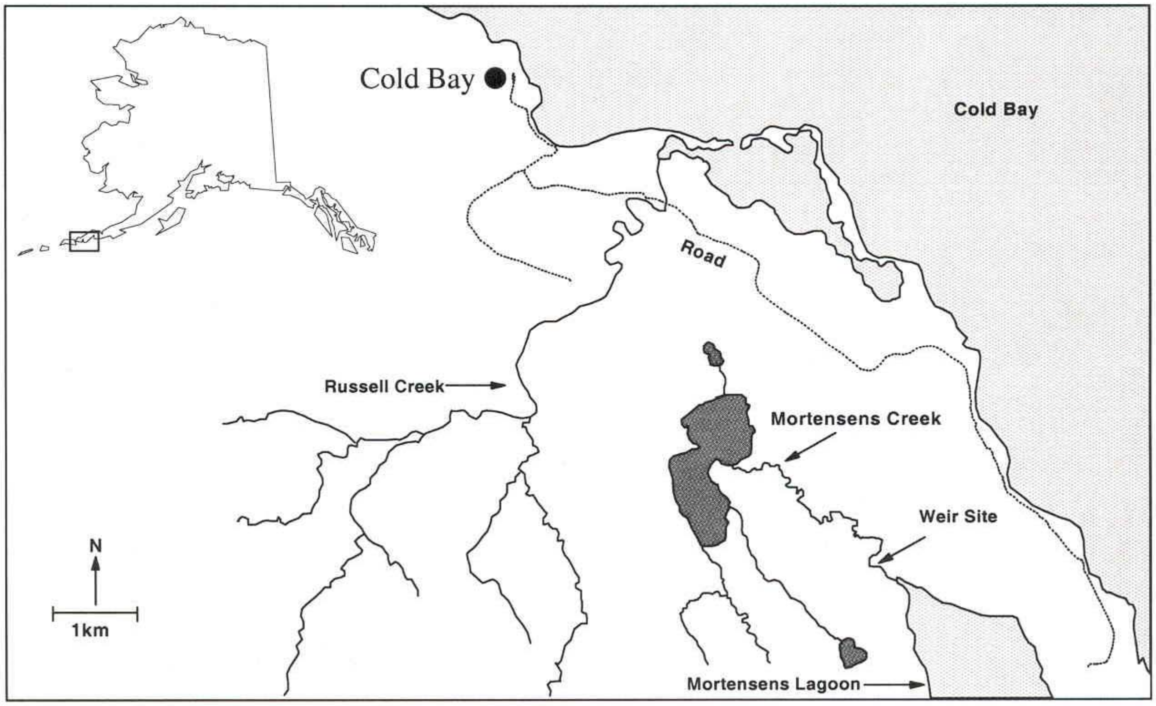


Figure 1. Map of Mortensens Creek and the weir site.

A Hobo® temperature data logger was installed at the weir to monitor water temperatures. Water temperature was recorded every two hours and summarized as daily maximum, minimum, and mean.

### *Biological Data*

Sockeye and coho salmon age, sex, and length (ASL) data were collected using a temporally stratified sampling design (Cochran 1977), with statistical weeks defining strata. Sockeye and coho salmon were sampled most weeks for ASL information, and to the extent logistically feasible, the sample was collected uniformly throughout each week (Sunday through Saturday). To avoid potential bias caused by the selection or capture of individual fish, all sockeye and coho salmon within the trap box were included in the sample, even if the target number of fish was exceeded. Weir passage was stratified into statistical weeks prior to sampling and was modified for analysis following the field season (Table 1). Sockeye and coho salmon were sampled primarily during high tides. During other times of the day, water depth often prevented upstream migration.

Maximum weekly sample size goals were established such that simultaneous 90% interval estimates of age composition for each week have maximum widths of 0.20 (Bromaghin 1993)

(Table 2). Sample sizes obtained using these methods were increased to account for the expected number of unreadable scales. The sample size goal was expected to be a substantial fraction of the salmon passage during some weeks; therefore, during weeks of low salmon passage we sampled about 20% of the weekly escapement. This was still sufficient to describe the age composition and reduced the number of salmon handled at the weir. Age categories were defined as the total age, fresh and ocean ages combined. Fish that could not be aged or where the sex could not be determined were dropped from all analysis.

Samples for ASL were collected using a dip net to remove fish from the holding pen. Fish were sampled at least once a day or more frequently as the number of fish moving through the weir increased. Sockeye and coho salmon were measured from mid-eye-to-fork (MEF), identified to sex using secondary sexual characteristics, and had scales collected for age analysis. One scale from sockeye salmon and three scales from coho salmon were removed from the preferred area on the left side of adult salmon (Jearld 1983). Scale samples were cleaned and mounted on gummed scale cards. The ADFG in Kodiak pressed and aged the scales. Salmon ages were reported according to the European method (Koo 1962). For sample size determination, major age categories were defined from previous work (Whitton 2002 and 2003; Cornum et al. 2004) as ages 1.2, 1.3, 2.2, and 2.3 for sockeye and ages 1.1, 1.2, and 1.3 for coho salmon (Table 1).

Table 1. Estimated maximum weekly sample size goals.

| Species | Number of Age Categories | Sample Size | Estimated Unreadable (%) | Adjusted Sample Size |
|---|---|---|---|---|
| Sockeye salmon | 11 | 121 | 15 | 148 |
| Coho salmon | 5 | 109 | 10 | 122 |

Characteristics of sockeye and coho salmon passing through the weir were estimated using standard stratified random sampling estimators (Cochran 1977). Within a given stratum *m*, the proportion of species *i* passing the weir that are of sex *j* and age *k* ($p_{ijkm}$) was estimated as

$$\hat{p}_{ijkm} = \frac{n_{ijkm}}{n_{i++m}},$$

where $n_{ijkm}$ denotes the number of fish of species *i*, sex *j*, and age *k* sampled during stratum *m* and a subscript of "+" represents summation over all possible values of the corresponding variable, e.g., $n_{i++m}$ denotes the total number of fish of species *i* sampled in stratum *m*. The variance of $\hat{p}_{ijkm}$ was estimated as

$$\hat{v}(\hat{p}_{ijkm}) = \left(1 - \frac{n_{i++m}}{N_{i++m}}\right) \frac{\hat{p}_{ijkm}\left(1 - \hat{p}_{ijkm}\right)}{n_{i++m} - 1},$$

where $N_{i++m}$ denotes the total number of species *i* fish passing the weir in stratum *m*. The estimated number of fish of species *i*, sex *j*, age *k* passing the weir in stratum *m* ($\hat{N}_{ijkm}$) was

$$\hat{N}_{ijkm} = N_{i++m}\,\hat{p}_{ijkm}\,,$$

with estimated variance

$$\hat{v}(\hat{N}_{ijkm}) = N_{i++m}^{2}\,\hat{v}(\hat{p}_{ijkm})\,.$$

Estimates of proportions for the entire period of weir operation were computed as weighted sums of the stratum estimates, i.e.,

$$\hat{p}_{ijk} = \sum_{m}\left(\frac{N_{i++m}}{N_{i+++}}\right)\hat{p}_{ijkm}\,,$$

and

$$\hat{v}\left(\hat{p}_{ijk}\right) = \sum_{m}\left(\frac{N_{i++m}}{N_{i+++}}\right)^{2}\hat{v}\left(\hat{p}_{ijkm}\right).$$

The total number of fish in a species, sex, and age category passing the weir during the entire period of operation was estimated as

$$\hat{N}_{ijk} = \sum_{m}\hat{N}_{ijkm}\,,$$

with estimated variance

$$\hat{v}\left(\hat{N}_{ijk}\right) = \sum_{m}\hat{v}\left(\hat{N}_{ijkm}\right).$$

If the length of fish of species *i*, sex *j*, and age *k* sampled in stratum *m* is denoted $x_{ijkm}$, the sample mean length of fish of species *i*, sex *j*, and age *k* within stratum *m* was calculated as

$$\bar{x}_{ijkm} = \frac{\sum x_{ijkm}}{n_{ijkm}}\,,$$

with corresponding sample variance $s_{ijkm}^{2}$

$$s_{ijkm}^{2} = \left(1 - \frac{n_{ijkm}}{\hat{N}_{ijkm}}\right)\frac{\sum\left(x_{ijkm} - \bar{x}_{ijkm}\right)^{2}}{n_{ijkm} - 1}\,.$$

The mean length of all fish of species *i*, sex *j*, and age *k* ($\hat{\bar{x}}_{ijk}$) was estimated as a weighted sum of the stratum means, i.e.,

$$\hat{\hat{x}}_{ijk} = \sum_m \left( \frac{\hat{N}_{ijkm}}{\hat{N}_{ijk}} \right) \bar{x}_{ijkm} .$$

An approximate estimator of the variance of $\hat{\hat{x}}_{ijk}$ was obtained using the delta method (Seber 1982),

$$\hat{v}\left(\hat{\hat{x}}_{ijk}\right) = \sum_m \left\{ \hat{v}\left(\hat{N}_{ijkm}\right) \left[ \frac{x_{ijkm}}{\sum_x \hat{N}_{ijkx}} - \sum_y \frac{\hat{N}_{ijky}}{\left(\sum_x \hat{N}_{ijkx}\right)^2} x_{ijky} \right]^2 + \left( \frac{\hat{N}_{ijkm}}{\sum_x \hat{N}_{ijkx}} \right)^2 s^2_{ijkm} \right\}.$$

While biological data were collected on a weekly basis, data strata were redefined for analysis to account for escapement during weeks when few or no salmon were sampled. After the season, sockeye and coho salmon escapement was divided in to five strata (Table 2).

Table 2. Strata (time periods) used for analysis of Mortensens Creek sockeye and coho salmon biological data, 2004.

| Stratum | Sockeye Salmon | Coho Salmon |
|---|---|---|
| 1 | 1 Jul - 17 Jul | 20 Aug - 4 Sep |
| 2 | 18 Jul - 24 Jul | 5 Sep - 11 Sep |
| 3 | 25 Jul - 31 Jul | 12 Sep - 18 Sep |
| 4 | 1 Aug - 7 Aug | 19 Sep - 25 Sep |
| 5 | 8 Aug - 5 Oct | 26 Sep - 5 Oct |

## Results

*Weir Operations*

Operation of the weir began 1 July and continued through 5 October 2004. Occasionally high tides associated with strong southeast winds resulted in high water exceeding the height of the weir (21 and 31 August, and 30 September – 5 October). On those days, it is likely that some fish may have passed upstream of the weir without being counted. On 30 September, high water washed out substrate from the center of the weir causing the center to become submerged and forced the video passage chute into the weir, rendering the video and passage chute inoperable. On 2 October, high water again washed out the substrate at the center and right of the weir. At this point, the entire weir needed to be removed and the substrate reinforced in order to maintain the integrity of the weir, consequently the weir was removed on 6 October.

Sockeye salmon were the most abundant species counted through the weir (*n*=7,215) followed by coho (*n*=3,836), pink (*n*=22), and chum salmon (*n*=13) (Appendix A). Dolly Varden (*n*=289), whitefish *Coregonus spp.* (*n*=21), and starry flounder *Platichthys stellatus* (*n*=68) were also observed at the weir. Sockeye salmon were counted at the weir from 1 July to 1 October 2004, with a peak of 1,527 fish (or 21% of the total run) passing the weir on 24 July (Figure 2; Appendix A). Coho salmon were counted at the weir from 20 August to 4 October, with a peak of 569 fish (or 15% of the total run) passing the weir on 10 September (Figure 2; Appendix A).

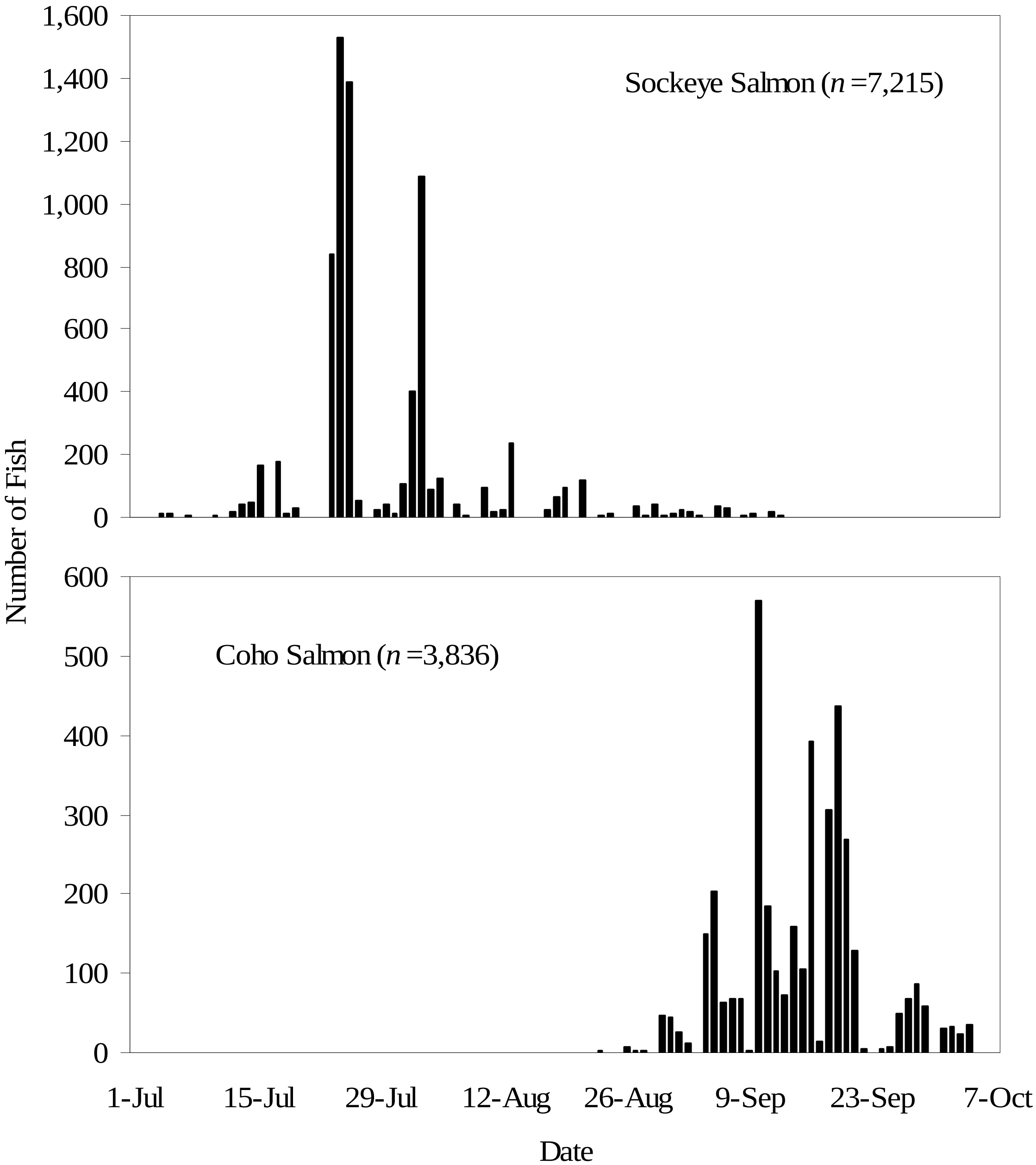


Figure 2. Daily counts of sockeye and coho salmon at the Mortensens Creek weir, 2004.

Water temperatures peaked at the weir in early July 2004 with a maximum temperature of 29.1°C recorded on 8 July (Appendix B). Temperatures fluctuated between 11°C and 17°C, from mid-July to late August and then gradually decreased until the data logger was removed on 5 October.

*Biological Data*

A total of 732 sockeye salmon were sampled for age, sex, and length data. Of that total, 116 (15.8%) fish could not be aged because of illegible or regenerated scales and 9 could not be sexed using secondary sexual characteristics. Eleven age classes were determined from scales collected in 2004. The majority of the run consisted of age 1.2, 1.3, 2.2, and 2.3 fish (Table 3). The estimated sex composition per stratum varied from 30% females in stratum 2 to 52% females in stratum 5 (Table 4). Females comprised 39% of the total sampled for the season. Sockeye salmon lengths ranged from 439 to 602 mm for females and 401 to 634 mm for males (Table 5).

A total of 515 coho salmon were sampled for age, sex, and length data. Of that total, 28 (5.4%) fish could not be aged because of regenerated scales and 3 could not be sexed using secondary sexual characteristics. Five age classes were determined from coho salmon scales collected in 2004. The majority of the run consisted of age 1.1 and age 2.1 fish (Table 6). The estimated sex composition per stratum varied from 29% females in stratum 1 to 56% females in stratum 3 and 5 (Table 7). Females comprised 51% of the total sampled for the season. Coho salmon lengths ranged from 431 to 699 mm for females and 348 to 701 mm for males (Table 8).

## Discussion

Sockeye salmon were captured the first day after the weir was installed. Since only one fish passed the weir on that date, I assumed that few sockeye salmon passed upstream prior to installation. Sockeye and coho salmon passed through the weir within five days before counting ceased. Therefore, it is likely part of the late run was missed. However, undercounting was more likely a problem during high tides combined with high winds blowing out of the southeast (21 and 31 August, and 30 September – 5 October). These conditions were less of a problem for sockeye salmon counts since the peak of the run occurred on 24 July. Based on aerial surveys, the Alaska Department of Fish and Game estimated sockeye salmon escapement at 10,100, using about a two-week stream life on the spawning grounds (Arnie Shaul, ADFG, personal communication), the weir counts were similar with an estimate of 7,215. The discrepancy between weir and aerial counts suggests that either a large number of sockeye salmon passed upstream of the weir without being counted or aerial counts overestimate the actual escapement. Even with the possible undercounting of sockeye salmon, the counts still exceeded the escapement goal (3,200 to 6,400).

In contrast, coho salmon numbers were less than all previous years since the weir began operating (Whitton 2002 and 2003; Cornum et al. 2004). The high tide-wind events that occurred in September and October likely allowed coho salmon to pass upstream of the weir undetected. Furthermore, coho salmon were passed through the weir two days prior to removal and the weir was removed 10 days earlier than in 2003, therefore, it is likely that part of the late run was underestimated. However, the peak of the run was on 10 September 2004 and in 2003 it was on 15 September; thus I assume that the majority of the run passed through the weir. No aerial surveys were conducted on coho salmon in 2004.

Table 3. Estimated age composition and standard errors of sockeye salmon by stratum in Mortensens Creek, 2004.

| | Age Class | | | | |
|---|---|---|---|---|---|
| | 0.3 | 1.2 | 1.3 | 2.2 | 2.3 |
| | | | **Stratum 1** | | |
| % | 4 | 18 | 43 | 16 | 16 |
| SE | 1.8 | 3.5 | 4.5 | 3.3 | 3.3 |
| *n* | 4 | 18 | 43 | 16 | 16 |
| | | | **Stratum 2** | | |
| % | 3 | 23 | 44 | 17 | 13 |
| SE | 2.2 | 5.3 | 6.2 | 4.7 | 4.1 |
| *n* | 2 | 15 | 28 | 11 | 8 |
| | | | **Stratum 3** | | |
| % | 2 | 20 | 37 | 22 | 16 |
| SE | 1.1 | 3.4 | 4.1 | 3.5 | 3.1 |
| *n* | 2 | 26 | 47 | 28 | 20 |
| | | | **Stratum 4** | | |
| % | 2 | 27 | 23 | 38 | 8 |
| SE | 1.6 | 4.7 | 4.5 | 5.1 | 2.9 |
| *n* | 2 | 23 | 20 | 33 | 7 |
| | | | **Stratum 5** | | |
| % | 2 | 25 | 25 | 30 | 15 |
| SE | 0.8 | 2.5 | 2.5 | 2.7 | 2.1 |
| *n* | 4 | 57 | 56 | 69 | 34 |
| | | | **Total**[a] | | |
| % | 2 | 23 | 35 | 25 | 13 |
| SE | 0.9 | 2.3 | 2.5 | 2.2 | 1.7 |
| *n* | 14 | 139 | 194 | 157 | 85 |

[a]Total number sampled does not include ages 0.2, 1.1, 1.4, 2.1, 2.4, 3.3 (*n*=15) because they were less than 2% of the sample.

Table 4. Estimated sex percentages, sample size, standard errors and escapement of sockeye salmon by stratum in Mortensens Creek, 2004.

| Stratum | *n* | Female % | Male % | SE | Escapement |
|---|---|---|---|---|---|
| 1 | 99 | 37 | 63 | 4.4 | 486 |
| 2 | 64 | 30 | 70 | 5.7 | 2,406 |
| 3 | 128 | 41 | 59 | 4.2 | 1,622 |
| 4 | 86 | 44 | 56 | 5.3 | 1,752 |
| 5 | 227 | 52 | 48 | 2.9 | 949 |
| Total[a] | 604 | 38 | 61 | 2.5 | 7,215 |

[a]Total number sampled does not include fish whose sex could not be determined (*n*=9).

Table 5. Minimum, mean, standard error, maximum, and sample size of lengths (mm) by age class taken from sockeye salmon at Mortensens Creek weir, 2004.

| | Age Class | | | | |
|---|---|---|---|---|---|
| | 0.3 | 1.2 | 1.3 | 2.2 | 2.3 |
| | | | **Female** | | |
| Mean | 553 | 503 | 551 | 500 | 551 |
| SE (%) | 12.6 | 16.6 | 8.3 | 11.3 | 12.0 |
| Min | 501 | 439 | 462 | 450 | 485 |
| Max | 575 | 602 | 590 | 564 | 594 |
| *n* | 12 | 56 | 84 | 60 | 49 |
| | | | **Male** | | |
| Mean | 570 | 510 | 584 | 520 | 572 |
| SE (%) | 19.0 | 23.9 | 10.5 | 15.9 | 23.3 |
| Min | 537 | 401 | 519 | 418 | 411 |
| Max | 598 | 618 | 632 | 634 | 632 |
| *n* | 2 | 83 | 110 | 97 | 36 |
| | | | **Total[a]** | | |
| Mean | 551 | 509 | 569 | 511 | 559 |
| SE (%) | 12.0 | 19.7 | 9.8 | 5.5 | 16.1 |
| Min | 501 | 401 | 462 | 418 | 411 |
| Max | 598 | 618 | 632 | 634 | 632 |
| *n* | 14 | 139 | 194 | 157 | 85 |

[a]Total number sampled does not include ages 0.2, 1.1, 1.4, 2.1, 2.4, 3.3 (*n*=15) because they were less than 2% of the sample or fish whose sex could not be determined (*n*=9).

Table 6. Estimated age composition and standard errors of coho salmon by stratum in Mortensens Creek, 2004.

| | Age Class | | | | |
|---|---|---|---|---|---|
| | 1.1 | 2.0 | 2.1 | 2.2 | 3.1 |
| | | | **Stratum 1** | | |
| % | 55 | -- | 45 | -- | -- |
| SE | 8.6 | -- | 8.6 | -- | -- |
| *n* | 17 | -- | 14 | -- | -- |
| | | | **Stratum 2** | | |
| % | 38 | 1 | 59 | 1 | 1 |
| SE | 4.4 | 0.8 | 4.4 | 0.8 | 0.8 |
| *n* | 43 | 1 | 66 | 1 | 1 |
| | | | **Stratum 3** | | |
| % | 34 | 1 | 62 | 1 | 2 |
| SE | 4.2 | 0.8 | 4.3 | 0.8 | 1.2 |
| *n* | 39 | 1 | 71 | 1 | 2 |
| | | | **Stratum 4** | | |
| % | 27 | -- | 70 | -- | 3 |
| SE | 5.3 | -- | 5.5 | -- | 2.0 |
| *n* | 18 | -- | 46 | -- | 2 |
| | | | **Stratum 5** | | |
| % | 22 | -- | 75 | -- | 2 |
| SE | 2.5 | -- | 2.6 | -- | 0.9 |
| *n* | 36 | -- | 121 | -- | 4 |
| | | | **Total** | | |
| % | 34 | 1 | 63 | 1 | 2 |
| SE | 2.3 | -- | 2.3 | -- | 0.6 |
| *n* | 153 | 2 | 318 | 2 | 9 |

Table 7. Estimated sex percentages, sample size, standard errors and escapement of coho salmon by stratum in Mortensens Creek, 2004.

| Stratum | *n* | Female % | Male % | SE | Escapement |
|---|---|---|---|---|---|
| 1 | 31 | 29 | 71 | 7.8 | 296 |
| 2 | 112 | 52 | 48 | 4.5 | 1,158 |
| 3 | 114 | 56 | 44 | 4.4 | 1,151 |
| 4 | 66 | 48 | 52 | 6.0 | 849 |
| 5 | 161 | 56 | 44 | 3.0 | 382 |
| Total | 484 | 51 | 49 | 2.4 | 3,836 |

Table 8. Minimum, mean, standard error, maximum, and sample size of lengths (mm) by age class taken from coho salmon at Mortensens Creek weir, 2004.

| | Age Class | | | | |
|---|---|---|---|---|---|
| Length | 1.1 | 2.0 | 2.1 | 2.2 | 3.1 |
| | | | **Female** | | |
| Mean | 590 | -- | 604 | -- | 597 |
| SE (%) | 27.6 | -- | 21.2 | -- | 294.3 |
| Min | 431 | 359 | 431 | 603 | 519 |
| Max | 682 | -- | 699 | -- | 657 |
| *n* | 73 | 1 | 173 | 1 | 5 |
| | | | **Male** | | |
| Mean | 591 | -- | 613 | -- | 622 |
| SE (%) | 24.1 | -- | 21.1 | -- | 20.5 |
| Min | 400 | 348 | 400 | 496 | 575 |
| Max | 688 | -- | 701 | -- | 654 |
| *n* | 80 | 1 | 145 | 1 | 4 |
| | | | **Total** | | |
| Mean | 591 | 354 | 608 | 549 | 607 |
| SE (%) | 24.1 | 3.7 | 19.9 | 35.9 | 23.9 |
| Min | 400 | 348 | 400 | 496 | 519 |
| Max | 688 | 359 | 701 | 603 | 657 |
| *n* | 153 | 2 | 318 | 2 | 9 |

Typically, visibility in Mortensens Creek is poor due to turbidity; this may have attributed to undercounting at the weir. However, installation of the video chute and camera appears to have improved fish detection and identification. For example, greater numbers of resident (Dolly Varden and whitefish) and other species (starry flounder) were identified and counted at the weir than previous years. I suspect that this is a result of the video camera that enabled detection and identification of these fish that would normally be missed, rather than an increase in actual fish numbers. The installation of the passage chute baffle brought fish closer to the field of view, making identification easier in turbid conditions, while video of recorded fish could be paused or rewound when large numbers of fish passed or visibility was poor. Given the benefits of the video and conditions of the water at Mortensens Creek, it is recommended that the video and passage chute be installed at the weir in 2005.

Water temperatures in 2004 were the warmest temperatures (12-14$^{o}$C above) recorded since the weir began operation and temperatures peaked approximately one month earlier than the previous recorded temperatures (Whitton 2002 and 2003; Cornum et al. 2004). This may have prompted fish to migrate earlier than previous years.

Age composition of coho salmon was similar to previous years (Whitton 2002 and 2003; Cornum et al. 2004). However, greater numbers of age 2.2 sockeye salmon were identified in 2004. Sockeye salmon tend to exhibit greater variation in age composition from year to year compared to other Pacific salmon (Burgner 1991). For example, conditions that attributed to slower growth in 2001 may have forced them to stay in fresh water longer, or they may have changes in the proportions of yearlings to two-year olds from brood year to brood year.

Sample size requirements for coho salmon exceeded the goal (5% were not aged). However, the sample size requirements for sockeye salmon were not met (16% were not aged). It is recommended that the sample size for sockeye salmon be increased in 2005 to account for problematic scales.

While escapement numbers indicate sockeye and coho salmon returns to Mortensens Creek are adequate to allow subsistence and sport fishing while sustaining these runs, monitoring should continue for at least two more years. This will allow better judgment of abundance trends and to obtain information on returns resulting from these escapements.

## Acknowledgements

The U.S. Fish and Wildlife Service, Office of Subsistence Management, provided funding support for this project through the Fisheries Resource Monitoring Program; project number FIS 04-402. I wish to thank the many people who helped with field work and data entry: Nick Gerrittson, Michael Malick, Brittany Blain, Adam Jensen, Dominick Barrett, and Michelle Rosen. I also thank the staff at the Izembek National Wildlife Refuge for logistical support.

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Appendix A. Summary of Pacific salmon daily passage at Mortensens Creek weir, 2004.

| | Sockeye | | Coho | | Chum | | Pink | |
|---|---|---|---|---|---|---|---|---|
| Date | Daily | Cum | Daily | Cum | Daily | Cum | Daily | Cum |
| 1-Jul | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2-Jul | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3-Jul | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4-Jul | 14 | 17 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5-Jul | 9 | 26 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6-Jul | 0 | 26 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-Jul | 3 | 29 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-Jul | 1 | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-Jul | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10-Jul | 3 | 33 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11-Jul | 0 | 33 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12-Jul | 20 | 53 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13-Jul | 41 | 94 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-Jul | 49 | 143 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15-Jul | 164 | 307 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16-Jul | 0 | 307 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17-Jul | 179 | 486 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18-Jul | 12 | 498 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19-Jul | 29 | 527 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20-Jul | 0 | 527 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21-Jul | 0 | 527 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22-Jul | 2 | 529 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23-Jul | 836 | 1,365 | 0 | 0 | 1 | 1 | 0 | 0 |
| 24-Jul | 1,527 | 2,892 | 0 | 0 | 3 | 4 | 0 | 0 |
| 25-Jul | 1,389 | 4,281 | 0 | 0 | 1 | 5 | 0 | 0 |
| 26-Jul | 55 | 4,336 | 0 | 0 | 0 | 5 | 0 | 0 |
| 27-Jul | 1 | 4,337 | 0 | 0 | 0 | 5 | 0 | 0 |
| 28-Jul | 22 | 4,359 | 0 | 0 | 0 | 5 | 0 | 0 |
| 29-Jul | 41 | 4,400 | 0 | 0 | 0 | 5 | 0 | 0 |
| 30-Jul | 9 | 4,409 | 0 | 0 | 0 | 5 | 0 | 0 |
| 31-Jul | 105 | 4,514 | 0 | 0 | 0 | 5 | 0 | 0 |
| 1-Aug | 404 | 4,918 | 0 | 0 | 1 | 6 | 0 | 0 |
| 2-Aug | 1,087 | 6,005 | 0 | 0 | 0 | 6 | 0 | 0 |

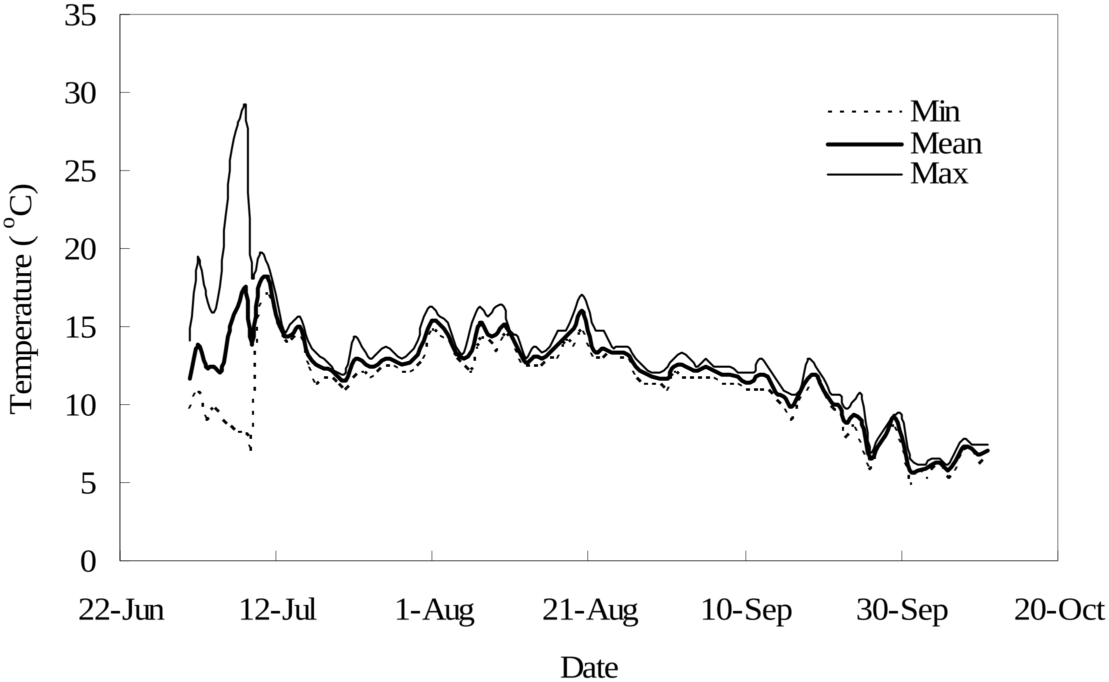
Appendix A. Continued.

| | Sockeye | | Coho | | Chum | | Pink | |
|---|---|---|---|---|---|---|---|---|
| Date | Daily | Cum | Daily | Cum | Daily | Cum | Daily | Cum |
| 3-Aug | 90 | 6,095 | 0 | 0 | 3 | 9 | 0 | 0 |
| 4-Aug | 122 | 6,217 | 0 | 0 | 1 | 10 | 0 | 0 |
| 5-Aug | 0 | 6,217 | 0 | 0 | 0 | 10 | 0 | 0 |
| 6-Aug | 42 | 6,259 | 0 | 0 | 1 | 11 | 0 | 0 |
| 7-Aug | 7 | 6,266 | 0 | 0 | 1 | 12 | 0 | 0 |
| 8-Aug | 1 | 6,267 | 0 | 0 | 0 | 12 | 0 | 0 |
| 9-Aug | 96 | 6,363 | 0 | 0 | 0 | 12 | 0 | 0 |
| 10-Aug | 15 | 6,378 | 0 | 0 | 0 | 12 | 0 | 0 |
| 11-Aug | 24 | 6,402 | 0 | 0 | 0 | 12 | 0 | 0 |
| 12-Aug | 238 | 6,640 | 0 | 0 | 0 | 12 | 0 | 0 |
| 13-Aug | 0 | 6,640 | 0 | 0 | 0 | 12 | 0 | 0 |
| 14-Aug | 0 | 6,640 | 0 | 0 | 0 | 12 | 0 | 0 |
| 15-Aug | 0 | 6,640 | 0 | 0 | 0 | 12 | 0 | 0 |
| 16-Aug | 25 | 6,665 | 0 | 0 | 0 | 12 | 1 | 1 |
| 17-Aug | 64 | 6,729 | 0 | 0 | 0 | 12 | 0 | 1 |
| 18-Aug | 94 | 6,823 | 0 | 0 | 0 | 12 | 1 | 2 |
| 19-Aug | 0 | 6,823 | 0 | 0 | 0 | 12 | 0 | 2 |
| 20-Aug | 120 | 6,943 | 1 | 1 | 0 | 12 | 1 | 3 |
| 21-Aug[a] | 0 | 6,943 | 0 | 1 | 1 | 13 | 0 | 3 |
| 22-Aug | 5 | 6,948 | 0 | 1 | 0 | 13 | 0 | 3 |
| 23-Aug | 9 | 6,957 | 3 | 4 | 0 | 13 | 1 | 4 |
| 24-Aug | 0 | 6,957 | 1 | 5 | 0 | 13 | 0 | 4 |
| 25-Aug | 0 | 6,957 | 0 | 5 | 0 | 13 | 0 | 4 |
| 26-Aug | 33 | 6,990 | 6 | 11 | 0 | 13 | 0 | 4 |
| 27-Aug | 4 | 6,994 | 3 | 14 | 0 | 13 | 0 | 4 |
| 28-Aug | 41 | 7,035 | 3 | 17 | 0 | 13 | 0 | 4 |
| 29-Aug | 6 | 7,041 | 1 | 18 | 0 | 13 | 1 | 5 |
| 30-Aug | 14 | 7,055 | 46 | 64 | 0 | 13 | 0 | 5 |
| 31-Aug[a] | 26 | 7,081 | 45 | 109 | 0 | 13 | 3 | 8 |
| 1-Sep | 18 | 7,099 | 25 | 134 | 0 | 13 | 1 | 9 |
| 2-Sep | 7 | 7,106 | 12 | 146 | 0 | 13 | 2 | 11 |
| 3-Sep | 0 | 7,106 | 0 | 146 | 0 | 13 | 0 | 11 |
| 4-Sep | 34 | 7,140 | 150 | 296 | 0 | 13 | 0 | 11 |

Appendix A. Continued.

| | Sockeye | | Coho | | Chum | | Pink | |
|---|---|---|---|---|---|---|---|---|
| Date | Daily | Cum | Daily | Cum | Daily | Cum | Daily | Cum |
| 5-Sep | 28 | 7,168 | 203 | 499 | 0 | 13 | 0 | 11 |
| 6-Sep | 1 | 7,169 | 62 | 561 | 0 | 13 | 0 | 11 |
| 7-Sep | 5 | 7,174 | 68 | 629 | 0 | 13 | 1 | 12 |
| 8-Sep | 10 | 7,184 | 68 | 697 | 0 | 13 | 0 | 12 |
| 9-Sep | 0 | 7,184 | 3 | 700 | 0 | 13 | 1 | 13 |
| 10-Sep | 17 | 7,201 | 569 | 1,269 | 0 | 13 | 5 | 18 |
| 11-Sep | 4 | 7,205 | 185 | 1,454 | 0 | 13 | 1 | 19 |
| 12-Sep | 2 | 7,207 | 103 | 1,557 | 0 | 13 | 1 | 20 |
| 13-Sep | 0 | 7,207 | 73 | 1,630 | 0 | 13 | 1 | 21 |
| 14-Sep | 0 | 7,207 | 159 | 1,789 | 0 | 13 | 0 | 21 |
| 15-Sep | 0 | 7,207 | 105 | 1,894 | 0 | 13 | 0 | 21 |
| 16-Sep | 2 | 7,209 | 392 | 2,286 | 0 | 13 | 0 | 21 |
| 17-Sep | 0 | 7,209 | 13 | 2,299 | 0 | 13 | 0 | 21 |
| 18-Sep | 1 | 7,210 | 306 | 2,605 | 0 | 13 | 0 | 21 |
| 19-Sep | 2 | 7,212 | 437 | 3,042 | 0 | 13 | 1 | 22 |
| 20-Sep | 0 | 7,212 | 268 | 3,310 | 0 | 13 | 0 | 22 |
| 21-Sep | 0 | 7,212 | 129 | 3,439 | 0 | 13 | 0 | 22 |
| 22-Sep | 0 | 7,212 | 4 | 3,443 | 0 | 13 | 0 | 22 |
| 23-Sep | 0 | 7,212 | 0 | 3,443 | 0 | 13 | 0 | 22 |
| 24-Sep | 0 | 7,212 | 5 | 3,448 | 0 | 13 | 0 | 22 |
| 25-Sep | 0 | 7,212 | 6 | 3,454 | 0 | 13 | 0 | 22 |
| 26-Sep | 2 | 7,214 | 48 | 3,502 | 0 | 13 | 0 | 22 |
| 27-Sep | 0 | 7,214 | 67 | 3,569 | 0 | 13 | 0 | 22 |
| 28-Sep | 0 | 7,214 | 87 | 3,656 | 0 | 13 | 0 | 22 |
| 29-Sep | 0 | 7,214 | 58 | 3,714 | 0 | 13 | 0 | 22 |
| 30-Sep[a] | 0 | 7,214 | 0 | 3,714 | 0 | 13 | 0 | 22 |
| 1-Oct[a] | 1 | 7,215 | 31 | 3,745 | 0 | 13 | 0 | 22 |
| 2-Oct[a] | 0 | 7,215 | 32 | 3,777 | 0 | 13 | 0 | 22 |
| 3-Oct[a] | 0 | 7,215 | 24 | 3,801 | 0 | 13 | 0 | 22 |
| 4-Oct[a] | 0 | 7,215 | 35 | 3,836 | 0 | 13 | 0 | 22 |
| 5-Oct[a] | 0 | 7,215 | 0 | 3,836 | 0 | 13 | 0 | 22 |
| **Total** | **7,215** | | **3,836** | | **13** | | **22** | |

[a]May be a partial count due to high tide-wind event.




Appendix B. Daily minimum, mean and maximum water temperatures near Mortensens Creek weir, 2004.